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Acronyms

AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
ASTM	American Society for Testing and Materials
BRA	Basewide Remedial Assessment
BWQAPP	Basewide Quality Assurance Project Plan
CFR	Code of Federal Regulation
CLP	Contract Laboratory Program
COC	chain-of-custody
COR	Contracting Officer's Representative
DNAPL	dense nonaqueous phase liquid
DO	dissolved oxygen
DOD	U.S. Department of Defense
DOT	U.S. Department of Transportation
DQE	data quality evaluation
DQO	data quality objectives
EB	equipment blank
EC	electrical conductivity
EPA	U.S. Environmental Protection Agency
EPCF	Environmental Process Control Facility
ERPIMS	Environmental Restoration Program Information Management System
EV	electron volt
FB	field blank
FD	field duplicate
FID	flame ionization detector
FTL	field team leader
GC/MS	gas chromatography/mass spectrometer
gpm	gallons per minute
HPLC	high performance liquid chromatography
HSP	Health and Safety Plan
ICPES	inductively coupled plasma emission spectroscopy
ID	inside diameter
IDW	investigation-derived waste(s)
IRP	Installation Restoration Program
IS	internal standards
IWCS	industrial wastewater collection system
IWTP	industrial wastewater treatment plant
LCS	laboratory control sample
L/min	liter per minute
LNAPL	light nonaqueous phase liquid
LOC	location
MCL	maximum contaminant level
MDL	method detection limit
MS/MSD	matrix spike/matrix spike duplicate

MEK	methyl ethyl ketone
ML	millileter
NEIC	National Enforcement Investigation Center
NGVD	national geodetic vertical datum
95 UCL	95-percent upper confidence limit
NIOSH	National Institute for Occupational Safety and Health
NOS	not otherwise specified
NTU	nephelometric turbidity units
ORP	oxidation reduction potential
OSHA	Occupational Safety and Health Administration
OVA	organic vapor analyzer
OVM	organic vapor monitor
PAH	polynuclear aromatic hydrocarbon
PARCC	precision, accuracy, representativeness, comparability, and completeness
PCB	polychlorinated biphenyl
PCE	perchloroethene or tetrachloroethene
PID	photo-ionization detector
PM	project manager
POC	point of contact
POL	petroleum, oil, and lubricants
ppb	parts per billion
PPE	personal protective equipment
ppm	parts per million
PQL	practical quantitation limit
QAO	quality assurance objective
QAPP	Quality Assurance Project Plan
QC	quality control
QCT	quality control tool
QPP	Quality Program Plan
RBP	rapid bioassessment protocols
RCRA	Resource Conservation and Recovery Act
RFI/CMS	RCRA facility investigation/corrective measures study
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
RPD	relative percent difference
RSD	relative standard deviation
SA-ALC	San Antonio Air Logistics Center
SAP	Sampling and Analysis Plan
SCPT	sonic cone penetrometer test or testing
SOP	standard operating procedure
SOW	statement of work
SPLP	synthetic precipitation leaching procedure
STP	sample tracking program
SVOC	semivolatile organic compound
TB	trip blank
TCA	trichloroethane
TCE	trichloroethene
TDS	total dissolved solids

TNRCC	Texas Natural Resource Conservation Commission
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TPM	technical project manager
UHP	ultra high purity
USCS	Unified Soil Classification System
UV	ultraviolet
VOC	volatile organic compound

SECTION 1.0

Introduction

This Sampling and Analysis Plan (SAP) presents the technical approach for performing field activities at Kelly Air Force Base (AFB). The technical approaches used in this document are consistent with the following documents: Kelly Air Force Base Technical Specifications (December 1998), Air Force Center for Environmental Excellence (AFCEE) Model, Field Sampling Plan (March 1998), AFCEE/Environmental Protection Agency Technical Protocol for Evaluating Natural Attenuation, and Clorinated Solvents (1998).

It provides procedures on the following activities:

- Mobilization
- Documentation
- Borehole drilling, lithologic sampling, logging, and abandonment
- Monitoring well construction
- Sampling methods
- Field equipment procedures
- Equipment calibration and maintenance
- Sample identification
- Quality control sampling
- Sample packing and shipping
- Variances and field changes
- Decontamination
- Sampling equipment
- Management of investigation-derived waste
- Surveying
- Certification of materials
- Aquifer testing

SECTION 2.0

Mobilization

2.1 Utility Clearance

2.1.1 Borings Located on Kelly AFB.

Borings (any subsurface penetration i.e.: borings, wells, CPT, geoprobes, etc.) located within Kelly AFB have strict utility clearance requirements. No drilling will commence in unauthorized areas that have not been cleared by the contractor. The Kelly AFB clearance is only good for ten calendar days.

2.1.2 Borings Located in City of San Antonio Rights-of-Way

Borings (any subsurface penetration i.e.: borings, wells, CPT, geoprobes, etc.) located within City of San Antonio rights-of-way have strict utility clearance requirements. No drilling will commence in unauthorized areas that have not been cleared by the contractor, including the city street-cut permit. An example of a utility clearance is shown in Appendix A. This clearance is only good for 10 calendar days.

A street-cut permit must be obtained from the City of San Antonio Department of Public Works, Streets and Drainage Division. Forty-eight-hour notice is required and a signed permit must be obtained before work can begin. As of April 1, 1998, the City of San Antonio also requires that the following items be submitted to install temporary monitoring wells in the city right of way:

1. Certificates of insurance from the consultants and/or drilling contractors. The City of San Antonio will be named as additional insured. A waiver of subrogation will also be provided.
2. A site location map and plan showing location(s) of the proposed monitoring wells
3. A typical well construction diagram indicating the design of the well(s) and depth
4. Boring logs, sample results, chain of custody, and sample locations for all samples collected in the monitoring wells, within a reasonable time after drilling the monitoring wells.

The street-cut permit will satisfy the requirements of the Environmental Services Division. However, signature by the Environmental Division is also required.

2.1.3 Internal Project Mobilization

Several internal tasks must be carried out before personnel proceed with fieldwork. These comprise project readiness review and include, but are not limited to, the following:

- Briefing field personnel on:

    The field assignment

The organization and chain of responsibility for the field team

An overview of the specific field tasks to be performed

Unique aspects of the work

- Assembling and preparing equipment for transport to the field
- Assembling and preparing expendable supplies for transport to the field
- Arranging transportation and lodging for field personnel

2.1.4 External Project Mobilization

Other mobilization efforts must be coordinated with personnel and organizations other than the contractor. In particular, the Kelly AFB Point of Contact (POC) is a focal point for matters related directly to Kelly AFB. A list of these items includes the following:

- Water access points
- 110/115-volt (V) alternating current (AC) electricity and potable water
- A location for the major equipment decontamination
- A storage area for containerized investigative wastes
- Coordination with Kelly AFB security personnel
- Coordination with Kelly AFB personnel to provide a community relations support during off-base activities

SECTION 3.0

Field Documentation

To document field activities, a site logbook, a field logbook, sampling log forms, and standard forms is maintained. All entries in the logbooks and sampling forms will be made in waterproof ink. Corrections will be made by drawing a single line through the entry, initialing, and dating the revision. All logbooks will be permanently bound and will have consecutively numbered pages. Blank pages will be marked through, dated, and initialed at the bottom. The individual responsible for documenting the day's field activities will sign and date the bottom of each page.

3.1 Site Logbooks

The person designated field team leader (FTL) maintains the site logbook, which chronicles all field sampling activities and is the governing record of these events but which does not have the same level of detail as the field logbook. The site logbook delineates conditions and activities occurring on a given day and references the appropriate field logbooks and forms for specific information. The site logbook also is used to record all field changes and supporting rationale. The FTL must sign and date the logbook at the end of each day's entry. Pages will not be removed from the document. All partially used pages must be lined out, dated, and initialed to prevent data entry at a later date.

The front cover or first page of the site logbook must list the project name, the project number, and dates of use. The following items are to be included, as appropriate to the work scope, in the site logbook:

- Date
- Weather conditions
- List of contractor personnel, subcontractor personnel, and site visitors by name, title, organization, and purpose who entered the project areas during the day
- Reference to all field logbooks used during the day by logbook number and pages
- Brief descriptions of sampling activities, including well numbers and sample identification(s)
- Field changes or variances, with references to the appropriate documentation of these changes
- Record of equipment decontamination, with references to specific documentation information
- Chain-of-custody (COC) details, including COC identification numbers, shipping receipt (air bill) numbers, sample identification numbers, and pertinent information related to sample status, which will be maintained in a separate sample tracking logbook

- Identification numbers, including model and serial numbers, of monitoring instruments used during the day and references to specific calibration logs
- Specific comments related to problems that occurred during the day and their resolution
- A record of telephone calls (incoming or outgoing) pertaining directly to the decision-making process of the field investigation and a brief description of the content of these conversations

3.2 Field Logbooks

Each sampling team must record information pertinent to field activities in a field logbook. All information required on the cover of the site logbook must also be provided on the cover of each field logbook. Entries in the field logbook must be made in real time and must be signed and dated by the responsible person at the end of each day. Unused pages or portions of pages must be lined out, dated, and initialed to prevent entry of additional information at a later date. Field logbook pages as well as the logbooks themselves will be numbered consecutively. The following information should be included in field logbooks:

- Date, time of specific activities, and physical location
- Weather conditions
- Names, titles, and organization of personnel onsite, names and titles of visitors, and times of visits
- Field observations, including details on sampling activities (including type of sampling, time of sampling, and sample numbers), a description of field tests and their results, and references to field forms used and/or type of document generated
- A detailed description of samples collected and splits, duplicates, matrix spikes, or blanks that were prepared, and a list of all sample identification numbers, packaging numbers, and COC form numbers pertinent to each sample or referenced to the appropriate documentation
- Specific problems, including equipment malfunctions and their resolutions
- A list of time, equipment type, and decontamination procedure followed (if different from the project work plan) or a reference to the appropriate documentation
- Where present, free product is measured with an oil/water interface probe and the results will be recorded in the field logbook and on the monitoring well purging log form. A free product notification form will be submitted to the Kelly AFB POC to record the date and time discovered, well number, location, and amount found.
- Unexpected or adverse field conditions that may inhibit the field team's ability to perform the day's activity or that may affect the accuracy of the data collected will be noted in the field logbook.
- Decontamination of purging and sampling equipment is documented in the field logbook. Equipment is documented in the field logbook by type, model number, and

serial number and may include water level indicators, pH meters, conductivity meters, Ponar grab samplers, turbidity meter and health and safety monitoring equipment.

- Other information recorded in the field logbook will include equipment calibration performed in the field, equipment calibration before transport to the sampling station, lot numbers and expiration dates of calibration fluids for pH meters, conductivity meters, turbidity meters and calibration gases for health and safety monitoring equipment.

Additional information may be recorded on field data log sheets (data sheets) at the discretion of the logbook user. Field logbooks will be made available upon request to the Kelly AFB POC.

3.3 Calibration Logbook

The calibration logbook is used to document calibration of all field testing equipment, such as pH meters, conductivity, turbidity, or temperature measuring instruments, providing the equipment can be calibrated. A calibration logbook will be maintained and will remain onsite throughout the project.

The calibration logbook is maintained as long as any instrument is calibrated in the field and will include the following:

- Date of calibration
- Identification number(s) of the instrument(s)
- Initials of person(s) performing the calibration
- Calibration solution lot number and expiration date

Additional information may be recorded at the discretion of the logbook user. All field instruments will be calibrated to the manufacturer's specifications. Copies of field calibration procedures will be kept in the calibration logbook.

3.4 Standard Field Data Forms

Standard forms provide a more detailed second record, in addition to the field logbook, and ensure that necessary data are recorded consistently. No blank spaces should appear on completed forms. If information requested is not applicable, the space should be marked with a dashed line or marked ***N/A***. All forms are to be completed in the field and placed in the project files. Examples of each of the field data forms are included in Appendix B. Standard forms will be used for the following types of information:

- Field blanks, equipment rinsate blanks, trip blanks, field duplicates, matrix spike/matrix spike duplicate samples

- Boring logs

- Well construction

- Well development

- Groundwater sampling, pH, conductivity, temperature, turbidity, dissolved oxygen (DO), oxidation reduction potential (ORP), and conditions of water samples (visual assessment, odor, and/or free product sheen)
- Aquifer test water level measurements
- ERPIMS field data for well construction and lithology
- Daily drilling diary
- Photo record file index

SECTION 4.0

Borehole Drilling, Lithologic Sampling, Logging, and Abandonment

4.1 General Drilling Procedures

All soil boring and well construction will be done in accordance with *Technical Design Specifications, Installation and Closure of Shallow Aquifer Wells, and Soil Borings on Kelly Air Force Base* (KAFB 1998) (Appendix C) unless an approved variance is obtained. All drilling activities will conform to state and local regulations and will be supervised by a hydrogeologist or geotechnical engineer. The contractor will obtain all permits, applications, and other documents required by state and local authorities. The contractor will also notify and await approval from the TNRCC for proposed monitoring well locations prior to drilling.

The drill rig will be cleaned and decontaminated in accordance with the procedure in Section 4. The drill rig will not leak any fluids that may enter the borehole or contaminate equipment placed in the hole. The use of rags or absorbent materials to absorb leaking fluids is unacceptable.

Lubricants will not introduce or mask contaminants. The contractor will provide chemical analyses of all lubricants proposed for downhole use. Chemical detection limits will be equivalent to those used in analyzing project groundwater samples. Lubricants with constituents that are toxic or that increase, decrease, or mask the target chemical species of the investigation will not be permitted.

A log of drilling activities will be kept in a bound field notebook. Information in the log book will include location, time on site, personnel and equipment present, down time, materials used, samples collected, measurements taken, and any other observations or information that would be necessary to reconstruct field activities at a later date. At the end of each day of drilling, the drilling supervisor will complete a Daily Drilling Log. Additional information on documentation of field operations is in Section 3.0.

4.2 Soil Logging

A professional hydrogeologist or geotechnical engineer will log the lithology in all boreholes. The boring log form or equivalent (see Appendix C) will be used for recording the lithologic logging information. Information on the boring log sheet includes the borehole location; drilling information; sampling information such as sample intervals, recovery, and blow counts; and sample description information.

Unconsolidated samples for lithologic description will be obtained at intervals prescribed in the project-specific workplan. Lithologic descriptions of unconsolidated materials encountered in the boreholes will generally be described in accordance with American Society for Testing and Materials (ASTM) D-2488-90 Standard Practice for Description and

Identification of Soils (Visual-Manual Procedure) (ASTM, 1990). Descriptive information to be recorded in the field will include:

1. Identification of the predominant particle size and range of particle sizes
2. Percent of gravel, sand, fines, or all three
3. Description of grading and sorting of coarse particles
4. Particle angularity and shape
5. Maximum particle size or dimension

Plasticity of fines description includes:

1. Color
2. Moisture (dry, wet, or moist)
3. Consistency of fine grained soils
4. Structure of consolidated materials
5. Cementation (weak, moderate, or strong)

The Unified Soil Classification System (USCS) group symbol will be used. Additional information to be recorded includes the depth to the water table, caving or sloughing of the borehole, changes in drilling rate, depths of laboratory samples, presence of organic materials, presence of fractures or voids in consolidated materials, and other noteworthy observations or conditions, such as locations of geologic boundaries.

4.3 Abandonment

Boreholes that are not converted to monitoring wells will be abandoned in accordance with applicable federal, state, or local requirements. A bentonite/cement grout slurry will be used that conforms to the manufacturer's specifications. The slurry will be placed from the bottom to the top of the hole using a tremie pipe for borings greater than 10 feet deep. Borings that are 10 feet deep or less may be plugged with a surface-pour method. The ground surface will be restored to the original condition such as grass, gravel, asphalt, or concrete.

All abandoned boreholes will be checked 24 to 48 hours after grout placement to determine whether curing is occurring properly. More specific curing specifications may be recommended by the manufacturer and will be followed. If settling has occurred, a sufficient amount of mud/solid bentonite will be added to fill the hole. These curing checks and any addition of mud/solid bentonite will be recorded in the field log.

SECTION 5.0

Monitoring Well, Test Well, and Piezometer Construction

Well and piezometer installation will include pads, identification plates, and well development. The hollow-stem auger drilling method will be used to advance all borings, unless otherwise specified.

Each well will be screened across the most conductive zone, unless otherwise specified. Ten feet of screen will be set in the most transmissive portion of the gravel, unless otherwise specified.

5.1 Drilling Requirements

All drilling and well installations will conform to state and local regulations and meet all the requirements of the Compliance Plan (Appendix B). The contractor will also obtain and pay for all permits, applications, and other documents required by state and local authorities. The location of all borings will be coordinated in writing with the base civil engineer or equivalent before drilling commences.

The rig will be cleaned and decontaminated according to the guidelines described in Section 7. The rig will not leak any fluids that may enter the borehole or contaminate equipment that is placed in the hole. The use of rags or absorbent materials to absorb leaking fluids is unacceptable. If drilling fluids are needed, the only acceptable fluids are air, water, and mud. The air used will be filtered to remove organic vapors, and if water is used, the contractor will provide chemical analyses of the water showing the purity. The water quality will be monitored daily for suspected analytes of concern. The mud used will be 100 percent sodium bentonite, and the drilling subcontractor will provide chemical analyses of any drilling mud additive or substitute (e.g., foam, biodegradable material, etc.) proposed for use. The additives or substitutes for drilling will be analyzed for parameters of concern and use of the additives will be approved by the Air Force prior to drilling mobilization.

When air is used, the effectiveness of the air filter will be checked at least every 4 hours. The air passing through the downstream end of the air line will be monitored with an organic vapor monitor (e.g., PID, organic vapor analyzer [OVA]), and if organic vapors are detected, their source (filter, contaminated line, etc.) will be decontaminated or replaced.

Drilling lubricants will not introduce or mask contaminants at the site. Contractors and any subcontractor will provide chemical analyses of all lubricants proposed for downhole use prior to the start of drilling upon request. Chemical detection limits will be equivalent to those used in analyzing project groundwater samples. Lubricants with constituents that are toxic or that increase, decrease, or mask the target chemical species of the investigation will not be permitted. The contractor or drilling subcontractor will provide the analysis results prior to drilling mobilization.

5.2 Borehole Requirements

Borehole diameters will be at least 4 inches larger than the outside diameter of the casing and well screen. The inside diameter of the hollow-stem auger for the installation of 2-inch-diameter monitoring wells will be at least 4.25 inches. The inside diameter of the hollow-stem auger for the installation of the 4-inch-diameter test wells will be at least 6 5/8 inches.

A completed monitoring well will be straight and plumb. A "rigid dummy", as required by the Technical Design Specifications will be lowered the entire length of the well to test for plumb. The monitoring well will be sufficiently straight to allow passage of pumps or sampling devices.

The documentation record and forms (Appendix B) will document the following information for each boring:

1. Boring or well identification (this identification will be unique, and the contractor is responsible for ensuring that it has not been used previously at the installation)
2. Purpose of the boring (e.g., soil sampling, monitoring well)
3. Location in relation to an easily identifiable landmark
4. Names of drilling contractor and logger
5. Start and finish dates and times
6. Drilling method
7. Types of drilling fluids and depths at which they were used
8. Diameters of surface casing, casing type, and methods of installation
9. Depth at which saturated conditions were first encountered
10. Lithologic descriptions and depths of lithologic boundaries
11. Sampling-interval depths
12. Zones of caving or heaving
13. Depth at which drilling fluid was lost and the amount lost
14. Changes in drilling fluid properties
15. Drilling rate
16. Drilling rig reactions, such as chatter, rod drops, and bouncing

A standard penetration test will be performed each time a split spoon sample is taken. The test will be performed in accordance with ASTM D 1586.

5.3 Casing Requirements

Monitoring well casing will consist of at least 2-inch inside diameter (ID) flush-threaded PVC (Schedule 40) and stainless steel (304) pipe. PVC will be placed from the surface to the saturated interval and stainless steel from the saturated interval to the top of the well screen. The saturated interval for the purposes of well construction will be the water level measured in the boring 15 minutes after collection of the final soil sample. Five feet will be added to the water level to accommodate for seasonal fluctuations in the water table. Test wells will have at least a 4-inch-diameter PVC (Schedule 40) casing and stainless steel (304) pipe. PVC will be placed from the surface to the saturated interval and stainless steel from the saturated interval to the top of the well screen. Piezometers will consist of flush-threaded at least 1-inch ID, Schedule 40 PVC casing.

The casing requirements that will be followed include:

1. All casing will be new, unused, and decontaminated according to the specifications of Section 7.
2. Glue will not be used to join casing, and casings will be joined only with compatible welds or couplings that will not interfere with the planned use of the well.
3. All polyvinyl chloride will conform to the ASTM Standard F-480-88A or the National Sanitation Foundation Standard 14 (Plastic Pipe System).
4. All metal casing will be seamless stainless steel casing, and the casing "mill" papers will be included in the appendix of the technical report.
5. The casing will be straight and plumb.
6. The driller will cut a notch in the top of the casing to be used as a measuring point for water levels.

5.4 Well Screen Requirements

Monitoring wells and test wells will have continuous-slot wire-wrapped stainless steel (304) screen. The screen will be 10 feet long with a slot size between 0.010 inch through 0.100 inch depending on the lithology. Piezometers will have machine-slotted PVC (Schedule 40) screen between 0.010-inch to 0.020-inch slot size.

Well screen requirements are as follows:

1. All requirements that apply to casing will also apply to well screen, except for strength requirements.
2. Monitoring wells will not be screened across more than one water-bearing unit.
3. Screens will be factory-slotted or wire-wrapped.
4. Screen slots will be sized to prevent 90 percent of the filter pack from entering the well, and for wells where no filter pack is used, the screen slot size will be selected to retain 60 to 70 percent of the formation materials opposite the screen.
5. The bottom of the screen is to be capped, and the cap will be joined to the screen by threads.

5.5 Annular Space Requirements

The annular space requirements are the following:

1. The annular space will be filled with a filter pack, a bentonite seal, and casing grout between the well string and the borehole wall.
2. Any drilling fluids will be thinned with potable water of known acceptable origin.
3. As the annular space is being filled, the well string will be centered and suspended such that it does not rest on the bottom of the hole.

5.5.1 Filter Pack Requirements

A sand pack consisting of durable graded quartz sand properly sized for the slot size of the screen shall be used. For a 4-inch well with 0.020 slot size, a sand pack consisting of durable graded quartz sand, with 100 percent passing through the Standard U.S. No. 6 sieve and 95 percent retained on the No. 9 sieve sand (6-9 sand), will be placed in the borehole annulus adjacent to the screen as the hollow-stem augers are slowly pulled from the borehole. For the 2-inch wells with 0.010-inch slot size, and piezometers with 0.010 slot size, a sand pack consisting of durable graded quartz sand, with 100 percent passing through the Standard U.S. No. 8 sieve and 95 percent retained on the No. 12 sieve sand (8-12 sand), will be placed in the borehole annulus adjacent to the screen as the hollow-stem augers are slowly pulled from the borehole. The subcontractor will provide the contractor with a grain-size analysis of each batch of sand used. The grain-size analysis must be provided before placement of any sand at the site. Any sand not conforming to the above specification will be rejected.

The filter pack will consist of silica sand or gravel and will extend from the bottom of the hole to at least 2 feet with a maximum of 4 feet above the top of the well screen. After the filter pack is placed, the well will be surged with a surge block for 10 minutes. The top of the sand pack will be sounded to verify its depth during placement. An additional filter pack will be placed as required to return the level of the pack to 2 feet above the screen. Surge the well for 5 minutes. Place additional filter pack as required to bring its level to 2 feet above the screen. If gravel is used, 6 inches of coarse sand will be placed on top of the gravel.

The filter pack material will be clean, inert, and well rounded and will contain less than 2 percent flat particles. The sand or gravel will be certified free of contaminants by vendor or a subcontractor.

The filter pack will have a grain size distribution and uniformity coefficient compatible with the formation materials and the screen, as described in *Ground Water and Wells*, (Driscoll, 1986). The filter pack will not extend across more than one water-bearing unit. In all wells (deep or shallow), the filter pack will be placed with a bottom-discharge tremie pipe. The tremie pipe will be lifted from the bottom of the hole at the same rate the filter pack is set. The onsite supervisor will record the volume of the filter pack placed in the well. Potable water may be used to place the filter pack so long as no contaminants are introduced. The contractor may use formation materials as a filter pack when the grain size is compatible with the slot size of the screen.

5.5.2 Bentonite Seal Requirements

The bentonite seal requirements are the following:

1. The bentonite seal will consist of at least 2 feet of bentonite between the filter pack and the casing grout.
2. Only 100 percent sodium bentonite will be used.

5.5.3 Casing Grout Requirements

The casing grout requirements are the following:

1. The casing grout will extend from the top of the bentonite seal to ground surface.

2. The grout will be mixed in the following proportions: 94 pounds of neat Type I Portland or American Petroleum Institute Class A cement, not more than 4 pounds of 100 percent sodium bentonite powder, and not more than 8 gallons of potable water.
3. All grout will be tremied using a side-discharge tremie pipe.

5.6 Surface Completion Requirements

A steel, flush-mount, three-bolt, painted, O-ring-sealed, 2- or 4-inch monitoring well (Broat-Longyear® type) protective cover will be placed over the well casing and anchored in concrete as shown. The subcontractor will provide a watertight locking cap; and it will be secured with a 1½-inch steel-shanked, brass-bodied Master® brand lock key No. 3446 for the well casing. All locks will be keyed alike and wells will be locked upon completion, or at a minimum, at the end of each working day. Only materials meeting the above specifications will be accepted. Well pads will be completed as shown in Appendix B. A well ID plate will be provided and installed on each well pad. The well ID plate will consist of a brass plate measuring 3 inches by 5 inches by 1/8 inch thick and will be permanently attached to the well pad for well identification information. This information will be stamped or embossed into the plate and will include the information illustrated in attached Figure C-7 (Appendix B).

5.7 Piezometer Requirements

A piezometer is a small-diameter cased borehole primarily used for water level measurements. The piezometer requirements are the following:

1. Piezometers will be constructed using methods or materials that do not contaminate groundwater or allow hydraulic communication between water-bearing units or between the ground surface and water-bearing units.
2. Piezometers that penetrate more than one water-bearing unit will be constructed in a manner that allows fluid from only one unit to enter them.
3. The straightness and plumbness of piezometers will be the same as for boreholes and monitoring wells, Sections 2.6.1 through 2.6.4.

5.8 Well/Piezometer Completion Diagrams

A completion diagram will be submitted for each monitoring well or piezometer installed. It will include the following information:

1. Well identification (this will be identical to the boring identification described)
2. Drilling method
3. Installation date(s)
4. Elevations of ground surface and the measuring-point notch
5. Total boring depth
6. Lengths and descriptions of the screen and casing

7. Lengths and descriptions of the filter pack, bentonite seal, casing grout, and any back-filled material
8. Elevation of water surface before and immediately after development
9. Summary of the material penetrated by the boring

5.9 Monitoring Well Development

The monitoring well development requirements are:

1. All newly installed monitoring wells will be developed no sooner than 24 hours after installation to allow for grout curing.
2. All drilling fluids used during well construction will be removed during development.
3. Wells will be developed using surge blocks and pumps (prior approval for any alternate method will be obtained, in writing, from the Air Force before well construction begins), and wells will be developed until:
   - Turbidity remains within a 10 nephelometric turbidity unit (NTU) range for at least 30 minutes
4. Discharge watercolor and volume will be documented.
5. No sediment will remain in the bottom of the well.
6. No detergents, soaps, acids, bleaches, or other additives will be used to develop a well.
7. All development equipment will be decontaminated according to the specifications of Section 7.

5.10 Abandoning Monitoring Wells

Abandonment of monitoring wells will be performed in accordance with state and local laws and regulations. Abandonment will consist of removal of the surface completion materials, pulling of the well casing (one attempt will be made without over-drilling), the borehole will be backfilled with a cement grout to within 6 to 12 inches of land surface, and the surface completion will conform to the surrounding area. A cement grout slurry mixture will be used that conforms to the manufacturer's specification. All abandoned monitoring wells will be checked 24 to 48 hours after mud/solid bentonite emplacement to determine whether curing is occurring properly. More specific curing specifications or quality assurance checks may be recommended by the manufacturer and will be followed. Additionally, if significant settling has occurred, a sufficient amount of mud/solid bentonite will be added to attain its initial level. These slurry/solid bentonite curing checks and any addition of mud/solid bentonite will be recorded in the field logs.

SECTION 6.0

Sampling Methods

Field activities at Kelly AFB may involve the following activities:

- Groundwater sampling
- Soil sampling
- Surface water sampling
- Sediment sampling
- Bioassessment sampling
- Fish tissue sampling
- Streamflow and surface water elevations

6.1 Measuring Free Product

Before groundwater samples are collected, all wells will be inspected to determine whether a free product contaminant layer is present. Floating contaminant layers are also referred to as light nonaqueous phase liquids (LNAPL). The floating contaminant layer will be measured either by collecting a sample in a clear Teflon™ disposable bailer or with an oil/water interface probe. If the oil/water interface probe is incapable of measuring floating product, then thickness of the product will be measured with a bailer. An interface probe will be used to determine if sinking, dense, nonaqueous phase liquids (DNAPL) are present. If present, this instrument will also be used to determine the thickness of the layer.

DNAPLs will be sampled, when present, by carefully lowering a depth-specific sampler or a discrete liquid sampler to the depth indicated by the interface probe. LNAPLs will be sampled, when present, by slowly lowering a clear Teflon™ disposable bailer to a point just below the top of the LNAPL layer. If water is collected along with the LNAPLs, the water will be allowed to flow out the bottom of the bailer into pre-preserved (if required) sample jars. During these procedures, care will be taken to minimize the amount of agitation to the sample.

The above procedures will be performed in the following order:

1. Measure the top of the LNAPL layer (if present)
2. Measure the top of the water
3. Measure the top of the DNAPL layer (if present)
4. Measure the total depth
5. Sample the LNAPL (if present)
6. Sample the groundwater
7. Sample the DNAPL (if present)

Existing wells at a site will be sampled starting with the cleanest (upgradient) wells and progressing downgradient to affected wells.

6.2 Groundwater Sampling

Groundwater Sampling Objectives:

- Collect a groundwater sample that is representative of the aquifer near the well being sampled.
- Collect sample free of suspended solids
- Avoid contamination of sample by stagnant water in well casing above the screen
- Avoid contamination of sample by surface soils
- Avoid aeration, hence potential volatization of target parameters, by purge and sample methods

Groundwater sampling includes site setup, well purging, sampling, site cleanup and equipment decontamination.

The following procedures will be used prior to groundwater purging and sampling from monitoring wells:

1. Calibrate pertinent health and safety equipment and field instrumentation (pH, temperature, turbidity, dissolved oxygen, ORP, and conductivity meters) before beginning work each day. pH meters will be calibrated immediately before a well is purged and immediately before the final value is measured. Duplicate measurements of pH, conductivity, temperature, and turbidity will be taken at a frequency of 1 in 10 samples and will be used to estimate the precision of the field analytical requirements.
2. Record well identification number and casing diameter and note the condition of surface completion on the groundwater sampling data sheet. A bailer will not be used to purge.
3. Remove the monitoring well cap and allow the well to vent for at least 10 minutes. Use an organic vapor monitor (OVM) or equivalent safety equipment to check for VOCs in the breathing zone and in the well casing. Record the concentrations on the groundwater sampling data sheet. Assess conditions surrounding the wellhead by comparing instrument readings to the action levels described in the Health and Safety Plan.
4. Construct a work area around the well head with plastic sheeting or similar material. Place all equipment that will be used in the sampling process on the sheeting.
5. Measure and record the depth to water and total well depth using an oil/water interface probe. If present, measure and record the free product thickness on the groundwater sampling data sheet. If free product is encountered, measure the thickness and collect a sample of the organic phase. Do not sample the water phase.
6. Determine if the well screen is partially or fully submerged by comparing the depth to water with screen depth.

6.2.1 Micropurge Sampling Procedures

The micropurging method described here has been adapted from protocols specified by EPA in their most recent groundwater monitoring guidance (EPA, 1992), demonstrated by Barcelona for providing consistent monitoring results for volatile constituents (Barcelona et al., 1994), and discussed in a recent EPA technical support document (Puls and Barcelona, 1996). The following procedures are written with separate steps for: 1) wells with no dedicated sampling system, which require a portable purge/sample pump; and 2) wells equipped with dedicated bladder pump systems.

1. Ensure that all equipment is properly operated and calibrated by following the equipment manuals provided by the equipment manufacturer. Record results of the equipment check in the log book.

2. Locate well and record well number, site, date, time, weather conditions, and condition of well completion on the groundwater sampling log and in the field log book.

3. Open well, noting condition of inner well seal/cap on the groundwater sampling log, and measure depth to water and total well depth with a decontaminated E-line. When preparing to sample a well which is screened at the base of the aquifer, first measure for the presence of a dense non-aqueous phase liquid (DNAPL). Lower a decontaminated oil/water interface probe into the well, record the depth to water, and slowly lower probe to the bottom of the well. A solid tone will sound if the probe encounters a DNAPL. Record the depth and thickness of any DNAPL detected, or note if no DNAPL was detected.

4. Check for presence of a floating free-phase product layer in the well with a clear, Teflon™ bailer.

5. Calculate total submerged casing volume.

Step 6a applies to the installation of a portable purge/sample pump to be used in wells with no dedicated sampling system:

6a Lower decontaminated pump into well. The pump intake should be set within the screened interval of the well, adjacent to the most transmissive zone as determined from drilling logs. If accurate drilling logs are not available, the pump will be set in the upper half of the screened interval immediately adjacent to the center point of the screened interval. Connect to electrical source (gasoline-powereed generators should be situated down-wind of the well head).

Steps 6b AND 7b apply to wells with dedicated bladder pump systems:

6b Connect air lines from regulated compressed gas source to control box.

7b Start gasoline powered air compressor (situate down-wind from well head) and start air flow, controlling discharge and refill cycle rate of the bladder with the knobs on the control box. Flow rate can be adjusted with the throttle knob on the control box.

8. Connect the flow-through cell to the discharge hose and direct the discharge into the 225-gallon tank located in the sampling van. Flow-through cell must be covered with an opaque material to prevent light from effecting turbidity readings.

9. Wells will be purged at a flow rate sufficiently low to draw down the water level in the well no more than 0.33 feet (0.1 meters). Drawdown will be continuously monitored during purging using a decontaminated E-line. Depth-to-water measurements will be recorded on the Groundwater Sampling Log.

10. Measure pH, specific conductance, temperature, dissolved oxygen, redox potential and turbidity of the discharge water throughout purging. Measurements should be recorded at a maximum interval of three minutes apart, and a minimum of 10 readings per purge. Purging will be complete when measurements of turbidity, redox potential, and dissolved oxygen have stabilized within approximately 10% over at least two successive measurements made three minutes apart. Record the water quality readings and the volume purged on the groundwater sampling log. If the well should be pumped dry during purging, the sampler will wait until sufficient water has recharged to the well to sample.

11. Reduce the pumping rate to between 100 and 300 ml/min. After the discharge rate has been lowered, purging should continue at 100-300 ml/min until a volume equal to the total volume of the pump and discharge tubing has been purged. Samples for VOA samples should be collected first, at the lowest flow rate possible, with no headspace remaining in capped vials. Care should be taken to avoid agitation and splashing of the sample.

12. Preservatives for VOA samples need to be added to the vial prior to sampling. One VOA vial should be filled with the sample, and drops of preservative added until the desired pH is reached (measure with pH paper). The same number of drops should then be added to the empty VOA vials prior to collection of the samples. Samples for other analyses should have the preservatives added to the full sample bottle, and a small amount will be poured into a small vessel, where the pH can be tested. Preservative will be added until the desired pH is reached.

13. Complete the sample labels accurately and legibly and affix to the sample bottles with clear packaging tape. Individual sample bottles (and groups of three VOA vials) will be placed in Zip-loc™ bags and stored on ice prior to shipping (see Section 9.0 and 15.0).

14. Collect and manage all wastes as outlined in Section 12.0.

15. Decontaminate all sampling equipment that has touched potentially contaminated water, soil or wastes (see Section 11.0).

6.2.1.1 Equipment and Material Requirements

The following checklist sets forth the equipment and materials needed for groundwatersample collection.

EQUIPMENT CHECKLIST

__	Monitoring well construction details (geologic log, screened interval, well depth, borehole diameter, etc).
__	Water level indicator with oil water interface probe
__	Bladder pump or Peristaltic pump
__	Fluoroethylene polymer (FEP) tubing in sufficient quantity to use new tubing for each well. Note: Teflon® is quite permeable to certain gases.
__	Throttling valves and 3-way flow-tee sampling valve
__	Control box
__	Compressed gas source
__	Field meters for pH, ORP, dissolved oxygen, temperature, electrical conductance (including instrument manuals and calibration materials)
__	Waste containers
__	Calibrated bucket or beaker to measure flow rate
__	Flow cell with ports for each of the field meter probes (optional)
__	Field documentation (logbooks, data sheets, chain of custody, forms, groundwater sampling)
__	Sample containers, preservatives, ice, and cooler(s)
__	Decontamination supplies
__	Electrical source (if needed)
	Personal protective equipment
__	Copies of approved sampling and Anlysis Plan (SAP), Site Safety and Health Plan (SSHP) and Water Management Plan (WMP).

6.2.1.2 General Pre-Sampling Procedure

Prior to purging and groundwater sampling, the routine procedures listed in the following checklist should be conducted.

PRE-PURGING CHECKLIST

__	Decontaminate submersible pump (if not dedicated tubing).

__ Decontaminate or replace discharge tubing (if not a dedicated pump).

__ Calibrate field meters (pH, ORP, specific conductance, dissolved oxygen, HNu, etc.). If possible, perform two-point calibration on DO meter.

__ Decontaminate water level indicator probe and tape.

__ Unlock the monitoring well and measure vapor concentrations in accordance with the site-specific Health and Safety Plan.

__ Measure depth to water.

__ Evaluate whether water table surface is above or within the screened interval.

__ Calculate the volume of water in the well and borehole filter sand pack pore space (borehole volume).

__ Insert dissolved oxygen probe in the monitoring well and measure the dissolved oxygen in the water column. If practical, also measure ORP of water in well.

__ Install submersible pump into the well slowly to minimize aeration, placing the pump intake within the screened interval or about 1 foot below the water level.

__ If gasoline or diesel powered generators or compressors are used to operate the pump, take precautions to prevent the exhaust from contaminating the samples.

__ Configure the discharge tubing with a gate valve and 3-way valve, with discharge directed through the 3-way valve and flow cell (optional), and into a calibrated decontaminated bucket.

6.2.1.3 Modified Low-Flow Sampling

Due to the low production capabilities of numerous monitoring wells at Kelly AFB, the following modified low-flow sampling technique may be used for wells that are unable to maintain a stable water level during low-flow purging. Each monitoring well must be purged before sampling to ensure that sampled groundwater represents conditions in the surrounding aquifer.

1. Low-flow procedures will be used for purging wells using a bladder pump set in the center of the screened interval or an approved surface pump with the tubing intake centered in the screen interval.
2. The water level will be monitored during purging of the monitoring wells. If the pumping rate cannot be adjusted to a point where it matches the well recharge rate, continue purging at the lowest possible rate, not below 0.05 L/min, and continue monitoring the water level.

3. Water quality parameters measured during purging will include DO, pH, temperature, ORP, specific conductivity, and turbidity at about 1-minute intervals. A flow-through cell will be used to assure reliability of the measurements by reducing exposure to the atmosphere.
4. If the DO, pH, and specific conductivity indicator parameters stabilize for three successive readings (within ±0.2 mgO_2, .10 pH unit, and ±10 us/cm), fill the sampling containers using a flow rate around 0.1 L/min.

6.3 Soil Sampling

Soil samples shall be collected based on odors, discoloration, organic vapor meter readings and any other field screening method.

6.3.1 Split-Spoon Samples

When soil samples are to be submitted for laboratory analysis, they shall be collected using stainless steel, continuous drive, California modified split-spoon samplers, or equivalent. These samplers are 24 inches in length and have an outside diameter (OD) of 3 inches to accommodate four 2-inch diameter brass/stainless steel rings, each of which is 6 inches in length.

Each time a split-spoon sample is taken, a standard penetration test shall be performed in accordance with ASTM D-1586, *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.* The sample is obtained by driving the sampler a distance of 1 foot into undisturbed soil with a 140-pound hammer free falling a distance of 30 inches. The sampler is first driven 6 inches to seat it in undisturbed soil, then the test is performed. The number of hammer blows for seating the spoon and making the test are then recorded for each 6 inches of penetration on the drill log (i.e., 5/7/8). The standard penetration test result (N) is obtained by adding the last two figures (i.e., 7+8=15 blows per foot). The sampler is then driven an additional 6 inches to fill the remainder of the split-spoon prior to retrieval.

As soon as the split-spoon is opened, the open ends of the brass/stainless steel rings shall be monitored for organic vapors using the PID or FID. Air monitor results shall be recorded on the boring log and in the field logbook.

Samples for VOC analysis shall be collected using an Encore® sampler. Samples collected concurrently with VOC samples to be tested for other analytical parameters shall be collected using an Encore sampler or by extruding the soil out of the brass/stainless steel rings immediately adjacent to (above and below) the VOC sample interval. Soil chemistry samples not being analyzed for VOCs shall be placed in 8 or 16-ounce, laboratory cleaned, EPA-approved glass containers with Teflon lined lids. This shall be done using clean stainless steel sampling tools. If soil from several brass/stainless steel rings must be composited to provide sufficient sample volume for a particular analysis, the sample shall be composited and homogenized in a stainless steel bowl using a stainless steel trowel or scoop. The sample shall then be transferred into the appropriate sample container, sealed, labeled, and place in an iced cooler held at a temperature below 4°C.

If initial screening results indicate the presence of organic vapors, a headspace analysis shall be conducted on remaining portions of the sample.

6.3.2 Sampling by Hand Auger

Hand augering is used to collect soil samples from depths up to 10 feet bgs, although the technique can sometimes be used to a depth as great as 30 feet bgs. This method is not appropriate for collecting samples for volatile organics analysis, because volatile compounds may be lost.

Each hand auger boring shall be advanced by manually turning a hand auger, equipped with 3-inch diameter cylindrical stainless steel bits, until the auger head fills with cuttings. The hand auger is then pulled from the boring and the cuttings shall be deposited on plastic sheeting. The hand augering is continued until the sampling depth is achieved.

At the predetermined sampling depth, a manually powered hammer is used to drive a sampler. The sampler is driven into the bottom of the boring to a depth of 6 inches, or until refusal. The sampler is then retrieved and the recovery is determined by estimating the percentage of the sample in the brass/stainless steel sleeve. The sample lithology is then described and recorded on the boring log.

The brass/stainless steel sleeve shall be capped with Teflon™ tape and end caps. The ends of the capped sleeve shall then also be wrapped with Teflon™ tape. Care shall be taken not to touch the ends of the sleeves prior to capping. Custody seals shall be placed across the capped ends of the sleeve. Once the container has been filled, the appropriate information shall be recorded in the field logbook.

6.3.3 Direct Push Sampling

Direct push sampling involves advancing a sampling probe from by direct hydraulic pressure or by using a slide or rotary hammer. Samples may be collected continuously or at specific depths. The samples are collected in brass/stainless steel sleeves. The sleeve shall be capped with Teflon™ tape and end caps. The ends of the capped sleeve shall then also be wrapped with Teflon™ tape. Care shall be taken not to touch the ends of the sleeves prior to capping. Custody seals shall be placed across the capped ends of the sleeve. Once the container has been filled, the appropriate information shall be recorded in the field logbook.

6.3.4 Surface Soil Sampling

Surface soil samples shall be collected from the land surface to six inches below the surface. The sample shall be homogenized and quartered before being containerized. If chemicals that are highly adsorbed to clay surfaces were released at the site, an additional sample shall be collected from the surface to the 1 inch depth.

Stainless steel scoops or trowels, glass jars with Teflon lids or equivalent equipment compatible with the chemical analyses proposed shall be used to collect and store samples. Exclude above ground plant parts and debris from the sample.

In addition to records outlined in Section 3.0, record unusual surface conditions that may affect the chemical analyses, such as the following:

(1) asphalt chunks that may have been shattered by mowers, thus spreading small fragments of asphalt over the sampling area,

(2) distance to roadways, aircraft runways, or taxiways,

(3) obvious, deposition of contaminated or clean soil at the site,

(4) evidence of dumping or spillage of chemicals,

(5) soil discoloration, and/or

(6) unusual condition of growing plants, etc.

6.4 Surface Water Sampling

When collecting surface water samples, an extra unused wide-mouth glass sampling jar will be used to transfer surface water from its source to a sample bottle. This prevents unnecessary contamination of the outer surface of the sample bottle, which might occur if the bottle were directly immersed in the surface water. Using this device also prevents the sampler from physically contacting the surface water. The transfer vessel will be disposed of after one use. If the sampling jar needs to be reused, the vessel should be thoroughly rinsed and/or decontaminated according to Section 11 before sampling a different source.

The following procedure will be used to collect surface water samples:

1. Determine location for collecting the sample. Samples must always be collected upstream of the sampler to prevent bottom silting of the water column, which is caused by the sampler's movements.

2. Invert the glass sampling container, immerse it 12 to 18 inches below the water surface, and turn upright (pointed towards the direction of current flow).

3. Allow the glass sampling container to fill slowly and continuously.

4. Retrieve the glass sampling container from the surface water with minimal disturbance.

5. Remove the cap from the sample bottle and slightly tilt the mouth of the bottle below the glass sampling container edge.

6. Empty the glass sampling container slowly, allowing the sample stream to flow gently down the side of the bottle with minimal entry turbulence.

7. For all samples except VOCs, continue delivery of the sample until the bottle is almost completely filled. Leave adequate space to allow for expansion. For VOCs, completely fill the bottle and verify that no air bubbles are present.

8. Preserve the sample if necessary.

9. Check that a Teflon™ liner is in the cap. Secure the cap tightly.

10. Decontaminate equipment as described in Section 11 or dispose of equipment as applicable.

6.5 Stream Sediment Sampling

Ponar grab samplers will be used to collect stream sediment samples. The Ponar grab is a clamshell-type scoop activated by a counter lever system. The shell is opened and latched in place and slowly lowered to the stream bottom. When the tension is released on the lowering cable, the latch releases and the lifting action of the cable on the lever system closes the clamshell.

Ponars can be used to sample most types of sludges and sediments, from silts to granular materials. They are available in a small version with a 232-square-centimeter sample area that is light enough to be operated without a winch or crane. Penetration depths usually will not exceed several centimeters. Grab samplers cannot collect undisturbed samples. As a result, material in the first centimeter of sludge cannot be separated from that at lower depths. The sampling action of these devices causes agitation currents, which may temporarily re-suspend some settled solids. This disturbance can be minimized by slowly lowering the sampler the last half meter and allowing slow contact with the bottom. Sludge or sediment samples should be collected only after all overlying water samples have been obtained.

The following procedure will be used to collect stream sediment samples:

1. Attach a pre-cleaned Ponar to the necessary length of sample line. Solid braided 5-millimeter (3/16-inch) nylon line is usually of sufficient strength; however, 20-millimeter (3/4-inch) or greater nylon line allows for easier hand hoisting.
2. Measure and mark the distance to the bottom on the sample line. A secondary mark, 1 meter shallower, will indicate proximity so that lowering pace can be reduced, preventing unnecessary bottom disturbance.
3. Open sampler jaws until latched. From this point on, support sampler by its lift line or the sampler will be tripped and the jaws will close.
4. Tie free end of sample line to fixed support to prevent accidental loss of the sampler.
5. Lower the sampler until the proximity mark is reached.
6. Slow the rate of descent through the last meter until contact is felt.
7. Allow the sample line to slack several centimeters. In strong currents, more slack may be necessary to release mechanism.
8. Slowly raise the sampler clear of the surface.
9. Place Ponar into a stainless steel or Teflon™ tray. Open Ponar and lift clear of the tray.
10. Collect a suitable aliquot for the VOC sample first with a stainless steel spoon or equivalent. Place sample into appropriate sample bottle. (Do not composite.) Collect sediment subsamples from the center of the aliquot. Avoid sediment that has come in contact with the side of the Ponar.

Decontaminate equipment as described in Section 11, or dispose of equipment as applicable.

6.6 Bioassessment Sampling

Biological survey of fish and macroinvertebrates will be conducted according to U.S. Environmental Protection Agency (EPA) rapid bioassessment protocols (RBP) for use in streams and rivers (EPA, 1989). Benthic macroinvertebrates will be collected according to RBP III.

Fish will be collected according to RBP V using electroshocking and seining in all available habitats. Fish will be identified to species, enumerated, observed for external anomalies, and released. Reference and unknown species will be preserved for laboratory verification. Fish collections will comply with the conditions of a scientific collector's permit, as supplied by the Texas Parks and Wildlife Department.

Habitat quality, based on key physical characteristics of the water body and surrounding land, will be evaluated at all five stations in accordance with EPA procedures (EPA, 1989). Parameters to be measured include, but are not limited to, surrounding land use, pollution sources, stream depth and width, sediment characteristics, water temperature, dissolved oxygen, pH, conductivity, odors, and visual classification of turbidity.

6.7 Fish Tissue Sampling

Tissue sampling will be conducted in accordance with the guidelines described in Appendix 9 of the Texas Natural Resource Conservation Commission (TNRCC) *Water Quality Monitoring Procedures Manual* (1994). The tissue sampling strategies will follow the objectives described for assessing ecosystem health. Each species sample will be a composite of three to five fish of the same species, with individuals varying in total length by 10 percent within the sample. The sampling team will try to collect the same three fish species at each station; however, some species may not be present at some stations because of variations in fish community structure.

6.8 Stream Flow and Elevation

Streamflow measurements will be taken twice at five sampling stations for each sampling event with a Marsh-McBirney Model 201 current meter or equivalent. Open channel flow measurements will be made using the Six-Tenths Depth Method or the Two-Point Method, as described in *Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge* (USGS, 1982). The Six-Tenths Method will be used if water depth is 2 feet or less and the Two-Point Method will be used if the water is deeper than 2 feet. Stream channels will be divided into 1-foot sections in narrow areas (< 20 feet) and up to 20 sections in wide areas (> 20 feet). The flow velocity will be taken in the center of each interval at 0.6 of the depth below the surface if less than or equal to 2 feet. If the depth is greater than 2 feet, the velocity will be recorded at 0.2 and 0.8 of the depth and averaged. Stream discharge will be calculated by summing all the interval discharges in the channel cross section. Flow measurements will be recorded on standard field data sheets.

6.9. Monitoring Well Purging for Bioattenuation Sampling

The objective of purging the monitoring well is to collect groundwater samples representative of the formation groundwater. At most petroleum hydrocarbon sites, the groundwater near the water table surface will have the highest constituent concentrations, and monitoring wells are therefore screened across the water table. In these wells, the pump intake should be placed about 1 foot below the water level. If the well has a discreet screen length that is entirely submerged, the pump intake should be placed within the screened interval.

To collect intrinsic bioremediation parameter samples, monitoring wells should be purged using the micro-purge technique (Section 6.2.2), at a rate that does not lower the water level significantly (i.e, less than 10 percent of the screen length). The specific pumping rate that will not cause excessive drawdown is dependent on the size of the well, permeability of the formation, etc. Check previous purge records for insight into the proper rate. When this information is not available, start with a flow rate of approximately 0.5 L/min and check the water level response in the well, increasing or decreasing the rate accordingly. The purging rate should be controlled as needed using the pump's variable speed flow controller and/or the gate valve in the discharge line. Collect water level measurements frequently during purging to ensure that the water level has not dropped lower than desired (see the attached sampling form). Monitoring wells should be purged, until DO, conductivity, and pH have stabilized to within the ranges presented in Table 6-1. If an electric submersible pump is used, temperature may slightly increase rather than stabilize during low flow rate purging.

TABLE 6-1
Criteria for Stabilization of Indicator Parameters during Purging

Field Parameter	Stabilization Criterion
Dissolved Oxygen	0.10 mg/L or 10% of value (whichever is greater)
Electrical Conductivity	3% Full Scale Range, $\pm$5-10 µmhos/cm
PH	0.10 pH unit

This method described above is recommended as an alternative to the conventional three-well volume purging protocol. Purging until the parameters in Table 6-1 have stabilized is a technically sound method for obtaining groundwater samples that are representative of formation groundwater. Most regulatory agencies accept this newer method based on its technical merits. However, some regulatory agencies may still require the older three-well volume method. For wells completed in very transmissive zones, it may not be practical to purge at a slow rate with minimal water table depression while still achieving the required purge volume. In these cases, a higher purge rate may be acceptable initially, but purging rates should be decreased as the required purge volume is approached, with the objective of producing groundwater samples that are not turbid and have not been artificially aerated.

As a cost-control measure, it may be appropriate to terminate purging and collect the sample at pre-determined, arbitrary endpoints (e.g., after three well volumes, after 1 hour of purging, etc.), regardless of whether or not the criteria in Table 6-1 have been achieved.

6.9.4 Field Indicator Parameter Measurement

During purging, continuously measure DO, electrical conductance, pH, ORP, and temperature with the flow cell or equivalent arrangement (e.g., discharge line from pump to small beaker in which the probes are immersed). Flow cells are commercially available from a number of vendors. If using the beaker arrangement for measuring the field indicator parameters, direct the discharge into the bottom of the beaker and allow the beaker to continuously overflow during measurements to minimize aeration. Allowing the discharge to pour into the container will artificially aerate the water, thus altering the properties of the water with respect to key parameters such as DO and ORP.

Record indicator parameter and water level measurements in a field notebook or onto well development logs every 3 to 5 minutes or at a minimum frequency of approximately ¼-well volume increments. Purging is complete once the parameters have stabilized to within the ranges presented in Table 6-1 regardless of the number of well volumes purged.

If using the electric pump, care must be taken to prevent flow interruption. If the flow is interrupted for any reason (e.g., loss of power), entry of air into the tubing usually occurs, with the potential result of artificially aerating the groundwater sample. In addition, restarting the pump may cause a surge in flow that will suspend particulate matter in the well.

6.9.5 Groundwater Sample Collection for Bioattenuation

When purging is complete, collect aliquots for the analytical parameters listed in Table 6-2. To ensure the most consistent, comparable results, individual samples and/or measurements from all wells should be collected in the same order. The order used in this protocol is based on the approximate order of susceptibility to artificial aeration: VOCs, total organic carbon (TOC), methane, iron, alkalinity, and sulfate.

Reduce the pumping rate and/or use the three-way valve to collect the methane, VOC, and TOC samples. Direct the discharge toward the bottom inside wall of the jar to minimize volatilization, and fill to overflowing. Filter the discharge prior to filling the ferrous iron sample jar using an in-line 0.45-micron filter. Filtration is recommended for a ferrous iron sample to eliminate bias introduced with particulates. In-line filtration is recommended to prevent artificial aeration of the ferrous iron sample.

If additional samples are collected for dissolved oxygen analysis using field kits (i.e, Winkler), submerge the sample jar into the bottom of the large container, continue to fill the container to overflowing, and allow the sample jar to fill without aeration.

Preserve and analyze the samples as described in the QAPP in Section 3.4.

TABLE 6-2
Kelly AFB Definitive Analytical Methods

Analyte Group	Parameter	Method Number	Matrix (a)
Natural Attenuation/General Chemistry			
	Nitrate/nitrite	SW9056	W
	Sulfate	SW9056	W
	Methane/ethane/ethene	RSK-175	W
	TOC	SW9060	S, W
	Hardness (as CaCO3)	E130.2	W
	Total dissolved solids (residue, filterable)	E160.1	W
	Sulfate (as SO4)	SW9056	W
	Alkalinity, total (as CaCO3)	E310.1	W
	Nitrogen, ammonia (as N)	E350.2	W
	Dissolved oxygen	E360.1	W
	Phosphorus, dissolved orthophosphate (as P)	E365.2	W
	Phosphorus, total orthophosphate (as P)	E365.2	W
	Phosphorus, dissolved (as P)	E365.3	W
	Biologic oxygen demand, 5 day	E405.1	W
	COD – chemical oxygen demand	E410.4	W
	Oil & grease, total recoverable	E413.1	W
	Methylene blue active substances	E425.1	W
	TPH	TX1005(c) and E418.1	S, W

6.9.6 Quality Control Check for Field Measurements during Bioattenuation Sampling

Field checks should be performed to ensure that representative measurements are being made. At a minimum, ORP and DO readings should be in agreement. DO readings should be less than one when the ORP is negative. If this is not the case, one or the other measurement is in error. When additional geochemical parameters are measured in the field, additional checks can be made. For example, ferrous iron should be present in elevated concentrations only when DO is less than one and the ORP is negative. When all measurements are not in agreement, measurements should be repeated until agreement is reached. In the process of achieving consistent results, there may be merit in trying alternative measurement techniques; for example, use of a field kit for DO rather than a DO measurement probe.

Another check for representative results can be made by comparing the DO and ORP of well water before and after purging. In almost all cases, the DO/ORP measurements taken from the well water prior to purging should be equal to or higher than the DO/ORP of the formation groundwater. Increase in the DO and ORP as a result of purging is an indication of artificial aeration of the water.

In many cases, generation of valid field measurements for these parameters is not a trivial matter. Consideration should be given to including an analytical chemist on the field sampling crew. If this is not practical, the field crew should be familiar with problems that may arise in obtaining valid measurements and/or have access to an analytical chemist who could help resolve measurement difficulties and apparent anomalies that may arise during sampling.

6.9.7 Recommendations for Bioattenuation Sampling

The following are recommendations that will facilitate implementation of the micropurging method and improve the representative quality of data collected.

- Wells should be thoroughly developed when installed at pumping rates greater than anticipated purging and sampling rates to eliminate or minimize production of sediment and colloidal particulates.
- Determine the depth of the well from well construction logs. Measuring the depth to the bottom of the well will cause suspension of settled solids and mixing of water within the well, thus requiring longer purge times. If well depth measurements are desired, perform the measurements after sampling is completed.
- Lower the pump slowly into the well to minimize surging the water column. Have the pump tubing measured and marked off before placing it down the well so you know where exactly to place the pump intake (i.e, 1 foot below water level or a minimum of 1 foot below the top of screen, whichever is lower).
- If using a submersible electric pump, use a generator that will allow the pump to run smoothly. Usually, a 2,500-watt with automatic throttle, supplying 15 amps or greater, works well.

- Do not start the pump too quickly. This may create a surge of water flow and cause unwanted turbidity in the sample. On the same note, make sure that you have a check valve on the pump tubing. If the pump shuts off accidentally, the check valve will prevent water in the tubing from rushing back into the well, causing the groundwater to be aerated.
- Select a pump setting low enough that it will not break suction and stop pumping. Check any previous records on the purge rates versus drawdown in the well. It is helpful to have some prior knowledge about the well's recharge rate and drawdown, so that stopping the pump, and/or lowering the pump are avoided. Periodically measure the water level in the well to prevent pump shutdown or drawdown that is too far down the well screen.
- Record data regarding the well's purge rate and drawdown for the next sampling event.
- Use tubing with as small a diameter as possible. If the submersible pump requires larger tubing, use a reducer to minimize the diameter of the tubing. Small-diameter tubing will reduce the chance of aeration within the tubing and improve the responsiveness of flow cell measurements (see the following bullet).
- Minimize the volume of water within the tubing and flow cell or beaker in which probe measurements are made. A large volume of water up-stream of the monitoring point (i.e. probe location) increases the amount of time required for steady-state conditions in the well to manifest themselves at the monitoring point. Flow cells or measurement beakers with a large volume and residence time are particularly problematic, due to the dilution effects and the longer time required to achieve a steady-state reading at the measurement point. Small-diameter flow cells that most closely achieve plug flow are preferred. If using a beaker set-up, try to ensure flow from the discharge tubing across the probes.
- Be careful of air bubbles trapped in the pump tubing. To minimize bubbles, hold the end of the groundwater discharge tubing vertical and higher than any other point in the tubing. It is also helpful to tap the tubing lightly to force bubbles to rise to the end of the tubing. It is important to minimize air bubbles because they could potentially aerate the groundwater sample.
- A three-way valve or tee with valves on two legs is recommended so that the pump rate is not altered and a constant flow rate can be maintained while sampling. The valve is configured so that one leg is connected to the discharge tubing, one leg flows into the flow cell, and the third is turned on only when filling sample bottles.

6.9.8 Consideration for Very Low Permeability Settings

Monitoring wells screened across very low permeability materials (silts, clays, etc.) typically purge dry and are then allowed to recharge prior to sampling. However, recharge into a dewatered well results in increased exposure of the water entering the well to the air present at the water table interface and in the well, potentially altering the groundwater geochemistry. To attempt to minimize these effects, the pump intake should be placed 2 to 3 feet below the water level and operated at as low a rate as is achievable, ideally equal to the recovery rate. In this manner, water drawn into the pump would be primarily from the formation and sand pack pore spaces. Close monitoring of the indicator parameter measurements is necessary since stabilization should occur prior to one borehole volume.

In some cases, a well may recharge so slowly that it may be impractical or even impossible to collect a groundwater sample that is truly representative of formation groundwater with respect to key geochemical parameters. If there is a need to collect samples/measurements for intrinsic bioremediation parameters in such cases, slowly purge the well dry and collect the groundwater samples as soon as the necessary volume has recharged into the well. The DO and ORP should be measured prior to, during, and after purging. An increase in DO or ORP is an indication of artificial aeration of the water, and results should be qualified accordingly.

SECTION 7.0

Field Instrument Calibration Procedures

Several types of real-time instruments can be used to monitor and evaluate the physical parameters of water and soil to determine the screening-level data. These screening level data can be used to monitor worker health and safety, to assist sample collection as well as to evaluate natural attenuation of certain contaminants in groundwater. Field screening for Kelly AFB investigations include, but are not limited to, the methods shown in Table 7-1.

Table 7-1
Field Screening Parameters

Parameter	Method Number	Matrix[b]
Organic vapor	FID or PID	Air
Stream flow	N/A	SW
Iron II	Hach Method No. 8146	GW
Hydrogen, dissolved	Bubble Strip Method[a]	GW
Alkalinity	Hach Kit Model AL AP-MG	GW
Specific conductivity	SW9050A	GW, SW
Redox potential	ASTM D1498-93	GW
Dissolved oxygen	E360.1	GW, SW
PH	SW9040B	GW, SW
Turbidity	E180.1	GW, SW
Temperature	E170.1	GW, SW

Notes:
[a]*Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA, 1998)
SW = surface water
GW = ground water

If different or additional field methods/instruments are needed for a specific effort, they will be specified in the site-specific work plans. Standard operating procedures (SOP) or manufacturer's instructions will be part of the site-specific work plan.

Calibration procedures, reporting limits and QC criteria for field screening methods are provided in the following text.

7.1 Water Sampling Instrument Calibration

7.1.1 Temperature Meter

This method is applicable to groundwater, surface water, saline water, and wastewater. Temperature measurements may be made with an analog or digital readout device or conductivity and pH meters that are equipped with a thermometer.

Allow the equipment probe enough time to equilibrate to the outside temperature when removed from a field vehicle. Insert the probe in situ when possible or in a grab sample. Swirl the probe in the sample and take the temperature reading when the readout needle stops moving; record temperatures to the nearest 0.5 degrees C. Routinely check the measurement device against a precision thermometer.

7.1.2 pH (Hydrogen Ion Concentration) Meter

This method is applicable to groundwater, surface water, saline water, and wastewater. The pH of a sample is determined electrometrically using either a glass electrode in combination with a reference potential or a combination electrode and a pH meter.

In general, the glass electrode is not subject to solution interference from color, turbidity, colloidal matter, oxidants, reductants, or high salinity. Errors resulting from the presence of sodium at pH levels greater than 10 can be reduced or eliminated by using a "low sodium error" electrode.

Coatings of oily material or particulate matter can impair electrode response. Remove these coatings by gently wiping with a laboratory tissue followed by an ASTM Type II water rinse.

Temperature effects on the electrometric measurement of pH are controlled by using instruments with temperature compensation or by calibrating the electrode meter system at the temperature of the samples.

Poorly buffered solutions with low specific conductance values (less than 200 μmhos) may cause fluctuations in pH readings. Equilibrate the electrode by immersing it in several portions of sample before taking the pH measurement.

The general test procedures are as follows:

1. Allow the meter to equilibrate to ambient temperature when it is removed from a field vehicle.
2. Buffer the meter at the temperature of the buffer solution.
3. If the sample temperature differs more than 2 degrees C from the buffer solutions, adjust for the temperature differences.
4. Thoroughly rinse the electrode with ASTM Type II water.
5. Immerse the electrode in situ when possible or in a grab sample. Swirl the electrode at a constant rate until the meter reading reaches equilibrium. The rate of stirring used should minimize the air transfer rate at the air/water interface of the sample.

6. Note and record sample pH. Repeat the measurement on successive volumes of sample or in situ until values differ by no less than 0.1 pH unit. Two or three volumes are usually sufficient.

7. In the case of low specific conductance samples, such as those encountered with some groundwater, add 1 milliliter (mL) of 1,000 micromhos per centimeter (nmhos/cm) potassium chloride solution per 100 mL of sample.

8. When the meter is moved to another sampling location, recheck the meter calibration by inserting the probe into the pH 7 buffer solution. The probe will be rinsed with ASTM Type II water before the probe is inserted or stored in the pH 7 buffer.

7.1.3 Specific Conductance Meter

This method is applicable to groundwater, surface water, saline water, and wastewater. The specific conductance of a sample is measured by using a self-contained conductivity meter. Measurements are made in situ or in a grab sample. Samples are preferably analyzed at 25 degrees C. If measurements are not performed at the specified temperature, temperature corrections are made and the results reported at 25 degrees C. Follow the manufacturer's instruction for the conductivity meter used.

7.1.4 DO Meter

DO measurements are taken using a YSI Model 57 DO meter, or equivalent, with temperature probe. Air calibration is performed at least twice during each sampling event, at the start and at the finish. The meter is calibrated by adjusting the zero and red line, allowing 10 to 15 minutes for probe polarization in a plastic calibration chamber, reading probe temperature and, based on local altitude and the YSI calibration table, adjusting the meter to the appropriate calibration value. During periods of heavy use or adverse field conditions, calibration is performed more frequently, based on the scientist's discretion.

7.1.5 Turbidity Nephelometer

Turbidity measurements are taken using a nephelometer. To calibrate the meter, the manufacturer's operating instructions should be followed. Measure standards on the meter covering the linear range of interest. If a wide range of turbidity is encountered, multiple calibrations will be required. If the instrument is already calibrated in standard turbidity units, this procedure will check the accuracy of the calibration scales.

7.2 Real-Time Organic Vapor Monitoring Instrument Calibration

The project Health and Safety Plan (HSP) will specify the personnel health and safety requirements for all field and laboratory analytical operations. Section 1.3 of the IRP Handbook (**AFCEE, 1993**) identifies the National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), and EPA guidance documents and appropriate federal regulations for developing HSPs.

Real-time OVMs are used to monitor total airborne organic vapors during field operations; the measurements are used to evaluate worker health and safety. Personal protective equipment (PPE) requirements and site control decisions will be determined according to the results of real-time measurements. Real-time instruments also provide screening-level data for VOC concentrations in drill cuttings, soil boring samples, and groundwater wells.

Several types of OVMs are available. Generally, these instruments utilize one of two primary detection methods for quantifying total airborne (VOC): a flame ionization detector (FID) or a PID. Suggested calibration frequencies for each commonly used instrument are presented in the following subsections. Because of the rigors of field use, backup instruments must always be available.

7.2.1 Flame Ionization Detector

FIDs measure total concentrations of hydrocarbon vapors. The instrument response for each specific compound is proportional to its response factor relative to methane. The instruments will be calibrated using methane-in-air standards.

The suggested calibration frequencies for field OVAs are:

- Factory calibration and service once per year
- Five-point calibration using four methane-in-air standards and ultra-high purity (UHP) air performed once each quarter
- Three-point calibration using two methane-in-air standards and UHP air prior to daily use
- Single-point calibration check uses a representative methane-in-air standard after each 4 hours of operation and at the end of each working day

7.2.2 Photoionization Detector

PIDs measure total organic vapors and are highly sensitive to aromatic compounds, moderately sensitive to unsaturated chlorinated compounds, and less sensitive to aliphatic hydrocarbons. The instrument responds to organic compounds with ionization potentials less than the rated electron voltage (eV) of the ultraviolet (UV) bulb in the unit. Because of its longevity and range of detectable contaminants, a 10.2-eV bulb is the most frequently used UV lamp. Other bulbs are available from the manufacturer (e.g., 9.5 eV, 11.7 eV, etc.). Field personnel will know which bulb is installed in the unit, ensuring that the instrument is capable of detecting the particular contaminant of interest.

Several manufacturers produce instruments with PIDs for field monitoring of airborne VOCs. The manufacturer's calibration requirements will be followed. Suggested guidance for PID calibration includes:

- Factory service and calibration once per year
- The HNU Systems PI-101 requires a three-point calibration on a quarterly basis using UHP air and two representative concentrations of isobutylene-in-air standards
- For any PID instrument, a two-point calibration prior to daily use (UHP air and a representative concentration of isobutylene-in-air standard)
- Single-point calibrations at the end of each day of use

7.3 Field Test Kits

Hach® field test kits will be used for a number of water quality parameters. The Hach® Water Analysis Handbook, Third Edition (1997), will be referenced along with the specific test parameters in the work plan when using any Hach® test kits.

7.4 Stream Flow Meter

This method is applicable to measuring channelized flow of a surface water body. Flow measurements will be taken with a Marsh-McBirney Model 201 current meter or equivalent. Open channel flow measurements will be made using the Six-Tenths Depth Method or the Two Point Method as described in *Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge* (USGS, 1982). The following steps outline stream flow metering; Table 7-2 summarizes calibration and quality control (QC) procedures for screening methods :

- Use the Six-Tenth Method if water depth is 2 feet or less, and the Two Point Method will be used if the water depth is greater than 2 feet.
- Divide channels into at least five equal intervals.
- Measure flow velocity in the center of the interval at a 0.6-foot depth below the surface if channel depth is less than or equal to 2 feet. If the depth is greater than 2 feet, record and average velocity at 0.2 and 0.8 of the depth.
- Calculate stream discharge by summing all the interval discharges in the channel cross section.
- Record flow measurements on standard field data sheets.

TABLE 7-2
Summary of Calibration and QC Procedures for Screening Methods

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Data Flagging Criteria[b]
SW9045C	pH (soil)	Two-point calibration with pH buffers	1 per 10 samples analyzed	± 0.05 pH unit	Check with new buffers; if still out, repair meter; repeat calibration check	R
		pH 7 buffer	At each sample location	± 0.1 pH unit	Recalibrate	R
		Duplicate sample	10% of field samples	± 0.1 pH unit	Correct problem, repeat measurement. If still out, repeat calibration and reanalyze samples	J
SW9050A	Conductance	Calibration with KCl standard	Once per day at beginning of testing	± 5%	If calibration is not achieved, check meter, standards,	R

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Data Flagging Criteria[b]
					and probe; recalibrate	
		Field duplicate	10% of field samples	± 5%	Correct problem, repeat measurement	J
SW9040B	pH (water)	2-point calibration with pH buffers	Once per day	± 0.05 pH units for every buffer	If calibration is not achieved, check meter, buffer solutions, and probe; replace if necessary; repeat calibration	R
		pH 7 buffer	At each sample location	± 0.1 pH units	Correct problem, recalibrate	R
		Field duplicate	10% of field samples	± 0.1 pH units	Correct problem, repeat measurement	J
E170.1	Temperature	Field duplicate	10% of field samples	± 1.0°C	Correct problem, repeat measurement	J
Hach AL AP MG Test Kit	Alkalinity	Field duplicate	10% of samples	± 20%	Correct problem, repeat measurement	J
Hach Method No. 8146	Iron II	Field duplicate	10% of samples	± 20%	Correct problem, repeat measurement	J
ASTM D1498	Oxidation-reduction potential	Sensitivity verification	Daily	ORP should decrease when pH is increased	If ORP increases, correct the polarity of electrodes. If ORP still does not decrease, clean electrodes and Repeat procedure	R
		Calibration with one standard	Once per day	Two successive readings ± 10 millivolts	Correct problem, recalibrate	R
		Field duplicate	10% of field samples	± 10 millivolts	Correct problem, repeat measurement	J
E360.1	Dissolved oxygen	Field duplicate	10% of field samples	RPD < 20%	Correct problem, repeat measurement	J
E180.1	Turbidity	Calibration with one forming a standard per instrument	Once per day at beginning of testing	± 5 units, 0–100 range	If calibration is not achieved, check meter; replace if necessary,	R

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Data Flagging Criteria[b]
		range used		± 0.5 units, 0–0.2 range ± 0.2 units, 0–1 range	recalibrate	
		Field duplicate	10% of field samples	RPD ≤ 20%	Correct problem, repeat measurement	J
None	Streamflow	Zero in stagnant water	Once per day at beginning of testing	Within 1% of zero	Recalibrate; Recalibrate check instrument and replace if necessary	
		Field Duplicate	10% of field samples			
None	Organic vapor concentrations (FID and PID)	3-point calibration	Monthly	correlation coefficient ≥ 0.995	Recalibrate; Recalibrate check instrument and replace if necessary	R
		Calibration verification and check	Daily at beginning and end of day	Response ± 20% of expected value	Correct problem, recalibrate	R

7.5 Specific Conductance Meter

The specific conductance of a sample is measured by using a self-contained conductivity meter. Measurements are made in situ or in a grab sample. Samples are preferably analyzed at 25° C. If not, temperature corrections are made and the results reported at 25° C. Follow the instructions manual for YSI Model 33 and 33M S-C-T meters or instructions for the conductivity meter used. Table 7-3 shows the specifications for two models.

TABLE 7-3
Specific Conductance Meter Specifications

Specification	Model 33S-C-T Meter	Model 33M S-C-T Meter
Ranges	0 to 500 µmhos/cm 0 to 5,000 µmhos/cm 0 to 50,000 µmhos/cm with 3,300 Series Probes	0 to 50 mS/m 0 to 500 mS/m 0 to 5,000 mS/m with 3,300 Series Probes
Accuracy	± 2.5% max. error at 500, 5,000, and 50,000 plus probes	± 2.5% max. error at 50, 500, and 5,000 plus probe ± 3.0 max. error at 25, 250, and 2,500 plus probe
Readability	2.5 µmhos/cm on 500 µmhos/cm range	0.25 mS/m on 50 mS/m range

TABLE 7-3
Specific Conductance Meter Specifications

Specification	Model 33S-C-T Meter	Model 33M S-C-T Meter
	25 µmhos/cm on 5,000 µmhos/cm range	2.5 mS/m on 500 mS/m range
	250 µmhos/cm on 50,000 µmhos/cm range	25.0 mS/m on 5,000 mS/m range
Temperature	None	None

A full description for operating this instrument is given in Appendix E.

7.6 Redox Meter

Redox will be measured using a YSI 600 XLM meter or equivalent to determine the oxidation-reduction potential in the field. This requires calibration of the instrument in accordance with ASTM D 1498-93 (see **Appendix C**). Specific steps in using the instrument are given in Appendix D.

7.7 Explosimeter

Explosimeter daily field calibrations are performed with a gas standard of 0.75 percent pentane, 15 percent oxygen, and 84.25 percent nitrogen.

7.8 Electrical Conductivity

Electrical conductivity meters are standardized in the field before each day's use with a 1,000 micromhos per centimeter (µmhos/cm) potassium chloride standard solution.

SECTION 8.0

Quality Control Samples

QC samples can be divided into five categories: field blank (FB), equipment rinsate blank (EB), trip blank (TB), field duplicate (FD), and matrix spike/matrix spike duplicate (MS/MSD).

8.1 Field Blank

An FB is a water sample collected in the field from deionized water used for decontamination. It is analyzed to test the source water for contamination. One field blank must be taken from each source of decontamination water for each sampling event.

8.2 Equipment Rinsate Blanks

An EB is a water sample prepared in the field by rinsing used decontaminated equipment with two-stage deionized water. The EB is used to test the adequacy of decontamination procedures and the presence of contaminants in the sampling equipment. EBs will be collected at a rate of one per day or one per event if using dedicated bailers.

For Teflon™ disposable bailers, the EB is poured from inside the bailer into the sample container. For the peristaltic pump, C-flex, and silicone tubing, the EB is poured into a decontaminated glass jar and pumped through new C-flex and silicone tubing into the sample containers with the peristaltic pump. For the surface water EB, water is poured into the dipper/device and then into each sample collection bottle. For the sediment EB, water is poured over the Ponar grab sampler and allowed to flow into the stainless steel tray. The water is then poured into each sample container.

8.3 Trip Blank

A TB is a water sample for VOC analysis only that is prepared from two-stage deionized analyte-free water at the Kelly AFB field trailer and carried into the field with the other sample containers. It is used to monitor cross-contamination of the samples in the sample storage environment. The TB is never opened in the field. One TB will be placed in each cooler containing VOC samples shipped from the field to the laboratory.

8.4 Field Duplicate

An FD is a second field sample taken in addition to the native sample to check repeatability or precision of data in the laboratory. FDs will be collected at a rate of 5 percent of all samples.

8.5 Matrix Spike/Matrix Spike Duplicate

An MS/MSD consists of a known amount of the analyte added to a sample. Spikes measure the accuracy of an analysis. For every 1 in 40 samples collected, one MS/MSD pair is analyzed. Accuracy is calculated as percent recovery (%R).

Matrix spike compounds are found on the target compound list. MS/MSDs are used to ascertain the effect of a specific sample matrix on the recovery of target compounds. MS/MSD results provide qualitative information about potential matrix interferences. Two aliquots of a sample are spiked with known amounts of target compounds and analyzed along with a native sample.

Accuracy is evaluated as %R of the known spikes. MS/MSD recoveries may also be used to estimate precision, which is a measure of the agreement or repeatability of a set of replicate results obtained from duplicate analyses made under the same conditions. Samples are never qualified on the basis of MS/MSD results alone, nor are samples reanalyzed if MS/MSD results are not within the method target acceptance limits. Matrix spike recovery limits are defined either by the Contract Laboratory Program (CLP) scope of work (SOW) (3/90, Revision 8 for VOCs, SVOCs, and pesticides/PCBs) or by the laboratory using laboratory-specific control charts.

SECTION 9.0
Sample Packing and Shipping

A field data manager and a sample custody manager will provide sample management teams with pre-labeled sample containers before the teams are mobilized to sampling locations. A description of the required type of containers, preservation techniques, minimum volumes for analysis, and holding times for handling environmental samples after collection and prior to analysis is presented in the July 1, 1988, issue of the Federal Register (40 Code of Federal Regulations [CFR] Chapter 1, Part 136.3, Table II).

Pre-cleaned sample bottles are received from the analytical laboratory and the supplier provides certificates of analysis with each lot of bottles. Internal laboratory QC checks are performed on selected bottles from each lot to ensure contaminate-free bottles are used in the field.

The sample custody manager will provide sampling teams with sample bottles at the beginning of each day. The bottles will be uniquely labeled with the laboratory, project, sample ID, station ID, preservation, analysis lot control ID, date and time of sample collection, and sampler's signature. Sample bottles will be pre-labeled with all this information but the date, time, and sampler's signature, which will be written in by the sampler immediately after collection.

The sampling team that collects the samples will retain custody in the field. Samples will remain in the possession of and in view of a member of the sampling team until they are placed in a designated secure area or relinquished to the sample custody manager.

Packaging and shipping procedures will be based on the following definitions:

- Low-concentration environmental samples are those collected in an area surrounding a spill or dump site. They are low in pollutant concentration and are collected from naturally occurring media such as lakes, streams, soils, and groundwater.
- High-concentration or hazardous samples are obvious waste samples collected from waste streams, tanks, or lagoons. As defined by the U.S. Department of Transportation (DOT), hazardous materials pose an unreasonable risk to health, safety, and property when transported in commerce.

9.1 Low-Concentration Samples

Low-concentration (soil or water) samples should be packaged and shipped as follows:

1. Place each sample bottle in a 2-millimeter plastic bag and seal the bag.
2. Fill a rigid insulated shipping container (cooler) one-quarter full of packaging material (vermiculite).
3. Place sample containers in the packaging material, leaving space between containers.

4. Fill several plastic bags with ice, seal the bags, and place between and on top of the samples to maintain temperature of 4 ±2 ° C for methods requiring temperature preservation, as listed in the QAPP.
5. Fill the cooler with packing material.
6. Place the required paperwork (COC records) going to the laboratory inside a plastic bag and tape it to the inside of the cooler lid.
7. Close the cooler, seal it with strapping tape, and place at least two custody seals over the edges (one on the front and one on the back hinge).
8. Deliver the cooler and a standard airbill to an express carrier for overnight delivery (if applicable).

9.2 High-Concentration Samples

High-concentration (waste) samples should be packaged and shipped as follows:

1. Sample jars should have at least 10 percent headspace and should be kept cooler than 130°F at all times as a matter of safety. (Sample integrity for analyses demands lower temperatures as described in the QAPP). If headspace will affect sample integrity, place the full sample container inside a larger container so the contents of the large container are less than 90 percent of its capacity.
2. Place each sample bottle in a plastic bag 2 millimeters thick or thicker and seal the bag.
3. Put each bottle in a clean, empty paint can, and fill the can with packing material.
4. Place the lid on each paint can, and seal each can with metal clips or tape.
5. Place arrows on the cans indicating which end should be up.
6. Write the proper shipping name and identification number on each can. Note: When the nature of the sample is uncertain, designate as flammable liquid or flammable solid. For flammable liquids, the proper shipping name is *Flammable Liquid, Not Otherwise Specified* (NOS) and the identification number is UN1993. For flammable solids, the proper shipping name is *Flammable Solid, NOS* and the identification number is UN1325. Proper shipping names of specific substances can be found in the DOT hazardous materials table (49 CFR 172.101).
7. Place the cans upright in a cooler and fill the cooler one quarter full with packing material. If space permits, the cans can be stacked on top of each other.
8. Fill several plastic bags with ice, seal the bags, and place them between and on top of the samples. Then fill the cooler to the top with packing material.
9. Place all required paperwork (COC record) inside a plastic bag and tape it to the inside of the cooler lid.
10. Close the cooler, seal it with strapping tape, and place at least two custody seals over the edges (one on the front and one on the back hinge).

11. Write the proper shipping name and identification number on the top and at least one side of the cooler.

12. Place a ***This End Up/Inside Packages Comply with Prescribed Regulations*** label on the top and all four sides of the cooler, with upward-pointing arrows on the sides of the cooler.

13. Place ***Flammable Liquid*** or ***Flammable Solid*** and ***Danger*** labels on all sides and the top of the cooler.

14. Write the address and addressee on the top of the cooler.

15. ***Cargo Aircraft Only*** labels must be used if the net quantity of sample in each outer container is greater than 1 quart for *Flammable Liquid, NOS* or 25 pounds for *Flammable Solid, NOS*.

16. High hazard airbills should be used for shipping. The "Shipper Certification for Restricted Articles" section should be filled out as follows:

    - Number of packages is number of coolers
    - Proper shipping name
      - Flammable Solid, NOS
      - Flammable Liquid, NOS
      - Classification
        - Flammable Solid
        - Flammable Liquid
      - Identification number (respectively)
        - UN 1325
        - UN 1993
    - Net quantity per package – number of containers per cooler
    - Radioactive materials section – leave blank.
    - Passenger/cargo aircraft – cross off the nonapplicable; up to 25 pounds of flammable solid per cooler can be shipped on a passenger aircraft; up to 1 quart of flammable liquid per cooler can be shipped on a passenger aircraft, and up to 10 gallons of flammable liquid per cooler can be shipped on a cargo aircraft
    - Print your name and title.
    - Give an emergency telephone number where you can be reached within the next 24 to 48 hours.
    - Sign the high hazard airbill.

17. Deliver the cooler and the high hazard airbill to an express carrier for overnight delivery.

SECTION 10.0

Variances and Field Changes

A variance is defined as a project change that would not significantly affect the quality of the data generated or changes the rationale of the field procedures and sampling locations. An example of a variance would be changing the size of the split-spoon sampler. All variances must be recorded in the site logbook and appropriate field logbook.

A field change is defined as a deviation from project requirements that will adversely affect the quality of the data generated or that will cause a significant change in the cost of the field effort, a major change in the scope of the field effort, or result in significant delays in the schedule. Examples of this type of change include the following:

- Changing the number of wells
- Changing the number of sampling points
- Changing decontamination procedures
- Changing drilling method or well construction design
- Changing sampling methodology

Field changes must be documented on the field change request form (Corrective Action Form, Appendix C) and submitted to the project manager for approval.

SECTION 11.0

Decontamination

The following subsections define the decontamination method and procedures to be used on major equipment, field equipment, water level measurement equipment, and downhole sampling equipment.

11.1 Decontamination of Major Equipment

The decontamination of major equipment, such as drill rigs, and sampling equipment is necessary to minimize the spread of contamination to clean zones, to reduce exposure to personnel, and to reduce cross-contamination of samples when equipment must be used more than once during a sampling event. Major equipment will be decontaminated using a high-pressure wash at the Kelly AFB Environmental Process Control Facility (EPCF). Smaller equipment such as split spoons for soil sampling or water level tapes will be cleaned at the sample location. Appendix E contains standard procedures for decontamination.

The basewide groundwater investigation is not expected to encounter high concentration (either dissolved or organic phase) contaminants. Three types of decontamination will be used during the investigation:

- Steam cleaning of large equipment at the on base decontamination pad
- Detergent-based decontamination of sampling equipment at the sampling site
- Detergent and organic solvent decontamination of sampling equipment that may have been exposed to high concentration contaminants or organic-phase contamination

11.2 Field Equipment Decontamination

During the field effort, glass jars for surface water sampling and Ponar grab samplers for sediment sampling will be decontaminated to avoid cross-contamination of samples. All equipment will be decontaminated using the following steps:

1. Phosphate-free soap/potable water mixture
2. Potable water rinse
3. Pesticide-grade methanol
4. Pesticide-grade hexane
5. Pesticide-grade methanol
6. Two-stage deionized water
7. Air dry

Stainless steel sprayers or Teflon™ spray bottles will be used to store and deliver two-stage deionized water and pesticide-grade methanol.

Water level indicators used to measure groundwater depths will be decontaminated with a pesticide-grade methanol wipe, followed by a two-stage deionized water wipe, and then allowed to air dry. Solvent-contaminated paper towels will be placed in separate containers supplied by Kelly AFB, labeled as hazardous waste, and staged for offsite disposal.

If procedures other than those listed below are to be used, or if modifications to approved procedures are proposed, a complete description will be submitted to the Kelly AFB POC and AFCEE COR for approval before field use.

Sampling equipment will be decontaminated using the following steps:

1. Phosphate-free detergent/potable water mixture
2. Potable water rinse
3. Air dry

If sampling equipment has been exposed to high-concentration contamination or organic-phase contamination, then the process will be as follows:

1. Phosphate-free soap/potable water mixture
2. Potable water rinse
3. Pesticide-grade methanol
4. Pesticide-grade hexane
5. Pesticide-grade methanol
6. Deionized water
7. Air dry

Small sampling equipment will be wrapped in aluminum foil after being decontaminated and will be stored in a clean area before use.

At the site, sampling equipment will not be allowed to come into contact with the ground or potentially contaminated surfaces. Sampling equipment will be decontaminated in tubs or drainage pans so that rinsate solvents can be collected and disposed of at the Kelly AFB EPCF. Rinsate samples (EBs) will be collected, as required, from the decontaminated sampling equipment by rinsing the cleaned equipment with deionized water. Major equipment will be decontaminated at a location designated by Kelly AFB.

Disposable material generated during decontamination (for example, gloves and Tyvek suits) will be bagged and placed in a 55-gallon drum provided by Kelly AFB. Solvent-contaminated paper towels will be placed in separate containers to be supplied by Kelly AFB, labeled as hazardous waste, and staged for offsite disposal.

11.3 Water Level Measurement Equipment

An electrical water level indicator meter or oil/water interface probe will be used to measure water levels in the monitoring wells. This equipment will be decontaminated by wiping the outside of the meter's tape with a paper towel saturated with pesticide-grade methanol followed by a deionized-water rinse while the tape is rolled onto the spool.

11.4 Downhole Sampling Equipment

Peristaltic pumps will be used to purge the monitoring wells and collect samples for field parameters. The silicone tubing, which is sent down the well, is connected to tubing around the peristaltic pump head and will be discarded between each monitoring well. New, factory-sealed silicone tubing used for purging and sampling with peristaltic pumps will be used at each monitoring well and then properly disposed of after one use. After purging with the peristaltic pump, the silicone tubing is withdrawn from the well and a new, sealed, disposable Teflon™ bailer is prepared with new polypropylene or polyethylene string and slowly lowered into the well to collect the organic samples.

The remaining organic samples will be collected with disposable Teflon™ bailers. Disposable Teflon™ bailers will not be cleaned, but will be disposed of after each use. Polypropylene or polyethylene string used to lower and retrieve bailers will be dedicated to each well for each sampling event and discarded after each use. Disposable sampling equipment will be stored in a 55-gallon drum provided by Kelly AFB for disposal.

SECTION 12.0

Management of Drilling Investigation-Derived Wastes

The drilling subcontractor will provide an adequate number of new DOT-approved, 55-gallon drums to containerize all drill cuttings, disposable materials, development water, and decontamination liquids. All disposable personal protective equipment (PPE), drill cuttings, development water, decontamination liquids, and other wastes produced from the drilling, monitoring well installation, monitoring well development, and aquifer testing operations will be placed by the subcontractor in the appropriate containers. The drilling subcontractor will be responsible for containerization, transportation and off-base disposal of all surface debris, specifically concrete and asphalt, generated during drilling and well pad installation. No on-base disposal of surface debris will be permitted. The drilling subcontractor will be responsible for hauling all waste containers to a staging area on Kelly AFB at the end of each working day.

The contractor will manage the sampling, characterization, and disposal of the investigation-derived wastes (IDW). The existing staging area at Main Kelly will be used for temporary storage of the soil cuttings. Soil cuttings will be characterized and disposed at a permitted facility if found to be non-hazardous. If cuttings are determined to be hazardous, the classification data will be delivered to Kelly AFB for disposal of the wastes by the base.

All purge, development, and other process waters generated as a direct or indirect result of investigation activities will be disposed of at the EPCF on Kelly AFB. The only exception to this policy will be in the event the EPCF is off line, or the waters are unacceptable for discharge to the EPCF. Prior to disposing of waters at the EPCF, the contractor will coordinate and schedule the discharge(s) with the EPCF manager. The contractor will record and report all discharges to the COR as a component of monthly status report. At a minimum, the contractor will report the date, quantity, origination site, and primary contaminants of interest at the site.

Construction debris disposal is the responsibility of the drilling subcontractor and will not be commingled with other IDW. Construction debris is defined as all non-affected residues of drilling subcontractor operations. Additionally, surface soils such as those excavated for the purpose of installing monitoring well pads will be treated as clean soil and distributed at the site, unless onsite distribution is impractical. Appendix E contains standard procedures for IDW.

SECTION 13.0

Surveying of Boring and Well Locations

All soil boring and well locations will be surveyed with a third-order accuracy. The required accuracy for well location is ±1 foot and is measured to a point on the well casing cover. The vertical plane (level circuit) survey elevations must be accurate to ±0.01 feet. The primary elevation point for the well is the top of the well casing along the lip. A notch must also scribe this point. Ground surface and depth to water will be measured from this point. In addition, the elevation of the outer protective casing (on the lip) or top of the traffic box must be measured. If an above-grade well completion is used, the elevation of the concrete pad must be measured.

SECTION 14.0

Certification of Materials

Documentation on the quality of materials used onsite (for example, well construction materials, sample collection materials, or equipment decontamination fluids) will be retained in the project files. Examples of this type of documentation will include the following:

- Manufacturer, lot number, and expiration date for calibration standards
- Certificates of analysis for decontamination fluids
- Sieve analyses of filter pack materials for wells and piezometers
- Catalog cuts, material certificates, and lot numbers for well construction materials, including screens, risers, and bentonite

SECTION 15.0
Sample Identification

The method of sample identification to be used depends on the type of sample collected, listed below, and the sample container type:

1. Samples collected for in-situ field analysis are collected for specific field analyses or measurements. The data are recorded directly in bound field logbooks or recorded on field data sheets along with sample identity information while in the custody of the sampling team.
2. Samples other than those collected for in-situ field measurements or analyses are identified on a sample label affixed to the sample container by the field data manager. The following information will be included on the sample label:
   - Laboratory
   - Project
   - Sample ID
   - Station ID
   - Preservation
   - Analysis
   - Lot control ID
   - Sampler's initials/date/time

The field data manager will assign each analytical sample. This number will be an alphanumeric code that identifies the installation, site, specific sampling location, and matrix sampled. These numbers will be used to track the sample from collection, through laboratory analysis, and into the final reports. The samples will have the following format:

ABCNNNXXX

where:

A	=	Project or task code
B	=	Year of sampling event (A = 1990, B = 1991, etc.)
C	=	Letter indicating sampling phase (e.g., A = initial event, B = second event)
NNN	=	Sequential number on the COC, beginning with 001
XXX	=	QA/QC identifier
		EB1 – equipment blanks
		FD1 – field duplicates

AB1 – ambient blanks

TB1 – trip blanks

For MS/MSD samples, they are noted as such in the comment field of the COC.

The sample number will be cross-referenced with the site name and sample location on the COC.

15.1 Sample Custody

The possession of samples or other evidence must be traceable from the time samples are collected until they are introduced as evidence in legal proceedings. This documentation will be accomplished through the use of a COC record (Appendix C). These forms will accompany the sample shipment and will be shipped in the appropriate shipping container (cooler). Copies of the completed COC forms will be included in appropriate data validation packages. Legal field custody will begin when clean sample containers are obtained from the laboratory and will end when those samples are relinquished to the laboratory for testing. This continuity will be reflected by the appropriate entries on the COC form.

A sample or other physical evidence is said to be under custody if:

- It is in the field investigator's physical possession.
- It is in the field investigator's view, after being in his/her physical possession.
- It was in the field investigator's physical possession and he or she secured it to prevent tampering.
- It is placed in a designated secure area.

15.2 Field Custody Procedures

Field custody procedures include the following steps:

1. To simplify the COC record and eliminate future problems, as few people as possible should handle the samples or physical evidence. For this reason, one individual from the field sampling team will be designated as the responsible individual for all sample transfer activities. This field investigator will be personally responsible for the care and custody of the samples collected until they are properly transferred to another person or facility.
2. Field documentation of each sample will be made on a sample log sheet or site logbook entry. This documentation will be made in ink and will consist of, at a minimum, entry of the sample identification number, the sample location, and the time and date of collection.
3. All samples will be accompanied by a COC record similar to the example presented in Appendix C. This record documents the transfer of custody of samples from the field investigator to another person, to the laboratory, or other organizational elements, as each change of possession must be accompanied by a signature for relinquishment and receipt of the samples.

4. Completed COC forms will be placed in a plastic cover and put inside the shipping container used for sample transport from the field to the laboratory.
5. When samples are relinquished to shipping companies for transport, the tracking number from the shipping bill or receipt will be recorded on the COC form or in the site logbook.
6. Custody seals will be used on the shipping containers when samples are shipped to the laboratory to ensure that no sample tampering occurred during transportation.

SECTION 16.0

References

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